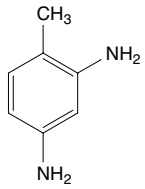
2,4-Diaminotoluene

CAS No. 95-80-7

Reasonably anticipated to be a human carcinogen

First listed in the *Second Annual Report on Carcinogens* (1981)



Carcinogenicity

2,4-Diaminotoluene is *reasonably anticipated to be a human carcinogen* based on sufficient evidence of carcinogenicity from studies in experimental animals.

Cancer Studies in Experimental Animals

2,4-Diaminotoluene caused tumors in rats at several different tissue sites and by two different routes of exposure. Oral exposure to 2,4-diaminotoluene caused liver cancer (hepatocellular carcinoma) in male rats, and subcutaneous injection of 2,4-diaminotoluene caused cancer (sarcoma) at the injection site in rats of both sexes (IARC 1978).

Since 2,4-diaminotoluene was listed in the *Second Annual Report on Carcinogens,* additional studies in rodents have been identified. Dietary administration of 2,4-diaminotoluene caused liver cancer (hepatocellular carcinoma) in female mice and increased the combined incidence of benign and malignant liver tumors (hepatocellular adenoma and carcinoma) in rats of both sexes. It also caused benign tumors of the subcutaneous tissue (fibroma) in male rats and increased the combined incidence of benign and malignant mammary-gland tumors (adenoma and carcinoma) in female rats. Lymphoma observed in female rats may also have been exposure-related (NCI 1979, IARC 1986). Administration of 2,4-diaminotoluene by stomach tube to male Eker rats (a strain with a high spontaneous incidence of kidney tumors) caused kidney cancer (carcinoma) (Morton *et al.* 2002).

Cancer Studies in Humans

No epidemiological studies were identified that evaluated the relationship between human cancer and exposure specifically to 2,4-diaminotoluene.

Properties

2,4-Diaminotoluene is an aromatic amine that exists at room temperature as colorless-to-brown needle-shaped crystals. It is slightly soluble in water and very soluble in alcohol, ether, and benzene. It is stable under normal temperatures and pressures (Akron 2009). Physical and chemical properties of 2,4-diaminotoluene are listed in the following table.

Property	Information
Molecular weight	122.2[a]
Specific gravity	1.045 g/m^3 at 20°C[b]
Melting point	99°C[a]
Boiling point	292°C[a]
Log K_{ow}	0.337[a]
Water solubility	7.74 g/L at 25°C[c]
Vapor pressure	5.52×10^{-5} mm Hg[a]
Vapor density relative to air	4.2[b]

Sources: [a]HSDB 2009, [b]Akron 2009, [c]ChemIDplus 2009.

Use

The primary use of 2,4-diaminotoluene has been as an intermediate in the production of 2,4-toluene diisocyanate, which in turn is used to produce polyurethane (HSDB 2009). 2,4-Diaminotoluene has been used in the production of about 60 dyes, 28 of which are believed to have been produced in significant amounts in the mid 1970s. These dyes generally have been used to color silk, wool, paper, furs, and leather. Some have also been used to dye cotton fibers and other cellulosic fibers, in spirit varnishes and wood stains, as indicators in the manufacture of pigments, and as biological stains. 2,4-Diaminotoluene has been used as a developer for direct dyes, particularly to obtain black, dark blue, and brown shades, and to obtain navy blue and black colors on leather. It was also used in hair-dye formulations until this use ceased in the United States in 1971 (IARC 1978). Other applications include the preparation of impact resins, polyamides with superior wire-coating properties, antioxidants, hydraulic fluids, urethane foams, and fungicide stabilizers, and as a photographic developer (HSDB 2009).

Production

2,4-Diaminotoluene has been produced commercially in the United States since 1919. It is produced as a mixture of four diaminotoluene isomers (2,4-, 2,6-, 2,3-, and 3,4-diaminotoluene) by nitrating toluene to the dinitrotoluene isomers and reducing the mixture to the diaminotoluene isomers (IARC 1978). In 2009, 2,4-diaminotoluene was produced by nine manufacturers worldwide, including two in the United States (SRI 2009), and was available from 25 suppliers worldwide, including 18 U.S. suppliers (ChemSources 2009). U.S. imports and exports of 2,4-diaminotoluene are reported as part of a category of similar compounds, including *o-*, *m-*, and *p*-phenylenediamine, diaminotoluenes, and their derivatives and salts. Imports in this category ranged from 660,000 to 1.5 million pounds between 1989 and 2002, increasing to 4.7 million pounds in 2009. During this period, exports in this category grew from 42 million pounds in 1989 to a high of 161 million pounds in 2000 and 2003; 106.5 million pounds was exported in 2008 (USITC 2009). Reports filed in 1986, 1990, and 1994 under the U.S. Environmental Protection Agency's Toxic Substances Control Act Inventory Update Rule indicated that U.S. production plus imports of 2,4-diaminotoluene totaled 100 million to 500 million pounds; the reported quantities fell to between 10,000 and 500,000 lb in 1998 and 2002 (EPA 2004).

Exposure

The routes of potential human exposure to 2,4-diaminotoluene are dermal contact, ingestion, surgical implantation, and inhalation (Sepai *et al.* 1995, Luu *et al.* 1998, EPA 2005, HSDB 2009, TRI 2009). 2,4-Diaminotoluene has been identified as a hydrolytic degradation product of polyester urethane foam used to cover silicone breast implants (Luu *et al.* 1998). Levels as high as 6 ng/mL were detected in plasma and urine of patients one month after surgery, and measurable levels were detected in patients up to two years after surgery (Sepai *et al.* 1995, Luu *et al.* 1998). Small amounts of 2,4-diaminotoluene have also been reported to be released from boil-in bags upon prolonged boiling (HSDB 2009).

It was estimated that 16.5 million pounds of 2,4-diaminotoluene was released during production in 1977 (HSDB 2009). According to EPA's Toxics Release Inventory, environmental releases of 2,4-diaminotoluene in most years before 2003 ranged from 500 to 4,000 lb and were mainly to air. However, over 6,000 lb was released to an off-site nonhazardous-waste landfill in 1991 and 54,000 lb to an off-site underground injection well in 1998. Since 2003, most 2,4-diaminotoluene waste has been sent to off-site hazardous and

nonhazardous waste landfills. In 2007, releases totaled 18,220 lb, of which 17,000 lb was released to an off-site hazardous-waste landfill and nearly all of the rest to air (TRI 2009). When 2,4-diaminotoluene is released to air, it may photolyze and react with photochemically generated hydroxyl radicals, with an estimated half-life of 8 hours. When it is released to water, it most likely will remain in solution, where it is subject to biodegradation and photooxidation. Because it is soluble in water and has a low soil sorption partition coefficient, it will most likely leach into the subsurface when released to soil. However, it is not likely to volatilize from either water or soil (HSDB 2009).

Because 2,4-diaminotoluene can be produced from the hydrolysis of toluene diisocyanate, an intermediate in the production of polyurethane, occupational exposure to 2,4-diaminotoluene can occur through inhalation of air in polyurethane manufacturing plants (IARC 1978, EPA 2005). The National Occupational Exposure Survey (conducted from 1981 to 1983) estimated that 8,511 workers (in the Textile Mill Products, Paper and Allied Products, Printing and Publishing, Chemicals and Allied Products, and Transportation Equipment industries), including 396 women, potentially were exposed to 2,4-diaminotoluene (NIOSH 1990).

Regulations

Environmental Protection Agency (EPA)

Clean Air Act

National Emissions Standards for Hazardous Air Pollutants: Listed as a hazardous air pollutant.

New Source Performance Standards: Manufacture or use of 2,4-diaminotoluene is subject to certain provisions for the control of volatile organic compound emissions.

Clean Water Act

Effluent Guidelines: Production is subject to discharge limitations.

Comprehensive Environmental Response, Compensation, and Liability Act

Reportable quantity (RQ) = 10 lb.

Emergency Planning and Community Right-To-Know Act

Toxics Release Inventory: Listed substance subject to reporting requirements.

Resource Conservation and Recovery Act

Listed as a hazardous constituent of waste.

Guidelines

National Institute for Occupational Safety and Health (NIOSH)

Listed as a potential occupational carcinogen.

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